| **Question** | **Scheme** | | | | | **Marks** |
| --- | --- | --- | --- | --- | --- | --- |
| **1(a)** |  | | | | | M1 |
| or 2 – 2i or exact equivalent. | | | | | A1 |
|  |  | | | | | **(2)** |
| **1(b)** |  | | | | | M1 |
| = – 8i | | | | | A1 cao |
|  |  | | | | | **(2)** |
| **1(c)** | If *z* is a root so is *z*\* So ( *x* – 2 + 2 i)(*x* – 2 – 2 i)  (or **)** | | | | | M1 |
| So ( *x* – 2 + 2 i)(*x* – 2 – 2 i) = 0 (or )  and so *p* = *q* = | | | | | M1 |
| Equation is or *p* = – 4 and *q* = 8 | | | | | A1 |
|  |  | | | | | **(3)** |
|  |  | | | | | **(7 marks)** |
| **2(a)** | , or equivalent | | | | | M1A1 |
| Solving 3-term quadratic by formula or completion of the square  or | | | | | M1 |
|  | | | | | A1 A1ft |
|  | 5            *O* | | | | | **(5)** |
| **2(b)** |  | | | | |  |
|  | ` | Two roots on imaginary axis | | | | B1ft |
| Two roots – one the conjugate of the other | | | | B1ft |
|  | Accept points or vectors | | | | | **(2)** |
|  |  | | | | | **(7 marks)** |
| **3(a)** |  |  | | | | B1 |
|  | Attempt to expand  or any valid method to establish the quadratic factor e.g. Sum of roots 6, product of roots 10 | | | | M1 |
|  | Attempt at linear factor with their *cd* in    Or  Or attempts f(2) | | | | M1 |
|  |  | | | | A1 |
|  | **Showing that** *f*(2) = 0 **is equivalent to scoring both M’s so it is possible to gain all 4 marks quite easily e.g.**  **B1, shows** *f*(2) **=** 0 **M2,**  **A1. Answers only can score 4/4** | | | | | **(4)** |
| **3(b)** | **Argand Diagram**  3, 1  3, -1  2, 0  -1.5  -1  -0.5  0  0.5  1  1.5  0  0.5  1  1.5  2  2.5  3  3.5  Re  Im | | | | | B1  B1 |
| First B1 for plotting (3, 1) and (3, -1) correctly with an indication of scale or labelled with coordinates (allow points/lines/crosses/vectors etc.) Allow *i*/-*i* for 1/-1 marked on imaginary axis.  Second B1 for plotting (2, 0) correctly relative to the conjugate pair with an indication of scale or labelled with coordinates or just 2 | | | | |  |
|  |  | | | | | **(2)** |
|  |  | | | | | **(6 marks)** |
| **4(a)** | *x*3 + *ax*2 + *bx* – 52 = 0, *a*, *b* ∈ ℝ | | | | |  |
|  | | | | | B1 |
|  |  | | | | | **(1)** |
| **4(b)** | or  ; | | | | | M1A1 |
|  | | | | | M1 |
| or | | | | | A1A1 |
|  |  | | | | | **(5)** |
|  |  | | | | | **(6 marks)** |
| **5** |  | |  | | |  |
|  | |  | | | B1 |
|  | | Substituting  and their *z*\* into | | | M1 |
|  | | Correct equation in *x* and *y* with  i2 = -1. Can be implied. | | | A1 |
|  | |  | | |  |
|  | | An attempt to equate real **and** imaginary parts. | | | M1 |
|  | | Correct equations. | | | A1 |
|  | |  | | |  |
|  | | Attempt to solve simultaneous equations to find one of *x* or *y*. **At least one of the equations must contain both *x* and *y* terms.** | | | M1 |
|  | | Both  and | | | A1 |
|  | |  | | | **(7)** |
|  |  | |  | | | **(7 marks)** |
| **6(a)** | So  or | | | | | M1M1  A1A1 |
|  |  | | | | | **(4)** |
| **6(b)** | and so | | | | | B1 |
|  |  | | | | | **(1)** |
| **6(c)** |  | | | | | B1 |
|  | | | | | M1A1 |
|  |  | | | | | **(3)** |
| **6(d)** |  | | | | | M1A1 B1ft |
|  |  | | | | | **(3)** |
| **6(e)** | *OP* and *QR* are parallel , and *QR* is twice the length of *OP*  **Or** Enlargement with Scale Factor 2 (centre *O*), followed by translation | | | | | B1B1 |
|  |  | | | | | **(2)** |
|  |  | | | | | **(13 marks)** |
| **7(a)** |  | | | | |  |
|  | | | | | M1 |
|  | | | | | A1 cao |
|  |  | | | | | **(2)** |
| **7(b)** |  | | | | | M1 |
|  | | | | | B1 |
|  | | | | | dM1A1 |
|  |  | | | | | **(4)** |
| **7(c)** |  | | | | | M1 |
|  | | | | | dM1 |
| *a* = 1, *b* = -1 | | | | | A1 |
|  |  | | | | | **(3)** |
| **7(d)** |  | | | | | M1 |
|  | | | | | A1 |
|  |  | | | | | **(2)** |
|  |  | | | | | **(11 marks)** |
| **8(a)** |  | | | | | M1 |
|  | | | | | A1 |
|  |  | | | | | **(2)** |
| **8(b)** |  | | | | | M1 |
| (Note: | | | | | M1A1 |
|  |  | | | | | **(3)** |
| **8(c)** |  | | | | | M1 |
|  | | | | | **d**M1 |
|  | | | | | M1 |
| (Note: | | | | | A1 |
|  |  | | | | | **(4)** |
| **8(d)** | , and | | | | |  |
|  | | | | |  |
| So real part of  = 0 or | | | | | M1 |
| So, | | | | | A1 |
|  |  | | | | | **(2)** |
|  |  | | | | | **(11 marks)** |
| **9(a)** | -7  -24  Im  Re | | | | Correct quadrant with  indicated. | B1 |
|  |  | | | |  | **(1)** |
| **9(b)** |  | | | | or | M1 |
|  | | | | awrt -2.86 or awrt 3.43 | A1 |
|  |  | | | |  | **(2)** |
| **9(c)** |  | | | |  |  |
|  | | | |  |  |
|  | | | | Attempt to apply | M1 |
|  | | | | Correct expression for *w*. | A1 |
|  | | | |  |  |
|  | | | | either  or | A1 |
|  |  | | | |  | **(3)** |
| **9(d)** |  | | | |  |  |
|  | | | | or i or awrt 97.1-23.8i | B1 |
|  | | | |  |  |
|  | | | | Applies or | M1 |
|  | | | | 100 | A1 |
|  |  | | | |  | **(3)** |
|  |  | | | | | **(9 marks)** |
| **10(a)** |  | | | | | M1 |
|  | | | | | M1 A1 |
|  | | | | |  |
|  | | | | |  |
|  | | | | | M1 |
|  | | | | | A1 A1 |
|  |  | | | | | **(6)** |
| **10(b)** |  | | | Centre in correct quad for their circle | | M1 |
| Passes through O centre in 4th quad. | | A1cao |
| Half line with positive gradient | | B1 |
| Correct position, clearly through (6, 0) | | B1 |
|  |  | | | | | **(4)** |
| **10(c)** | Equation of line | | | | | B1 |
| Attempting simultaneous solution of  and | | | | | M1 |
|  | | | | | A1 |
|  | | | | | A1cao |
|  |  | | | | | **(4)** |
|  |  | | | | | **(14 marks)** |
| **11(a)** |  | | | | |  |
| 11.1803... | | | | | B1 |
|  | | | | | M1 |
|  | | | | | A1 oe |
|  |  | | | | | **(2)** |
| **11(b)** |  | | | | |  |
|  | | | | | B1 |
|  | | | | | M1 |
|  | | | | | M1 |
|  | | | | |  |
|  | | | | |  |
| (Note: | | | | | A1 |
|  |  | | | | | **(4)** |
| **11(c)** |  | | | | |  |
|  | | | | |  |
|  | | | | | M1 |
| So, | | | | | A1 |
|  |  | | | | | **(2)** |
|  |  | | | | | **(9 marks)** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Source paper** | **Question number** | **New spec references** | **Question description** | **New AOs** |
| 1 | FP1 2016 | 4 |  | Complex numbers | 1.1b, 3.1a |
| 2 | FP1 Jan 2013 | 5 |  | Complex numbers | 1.1b, 3.1a |
| 3 | FP1 Jan 2012 | 5 |  | Complex numbers | 1.1b, 3.1a |
| 4 | FP1 2017 | 6 |  | Complex numbers | 1.1b, 3.1a |
| 5 | FP1 2011 | 6 |  | Complex numbers | 1.1b |
| 6 | FP1 2016 | 7 |  | Complex numbers | 1.1b, 2.1, 3.1a |
| 7 | FP1 2013 | 7 |  | Complex numbers | 1.1b, 3.1a |
| 8 | FP1 2012 | 7 |  | Complex numbers | 1.1b, 3.1a |
| 9 | FP1 2011 | 7 |  | Complex numbers | 1.1b, 3.1a |
| 10 | FP2 2012 | 8 |  | Further complex numbers | 1.1b, 2.1, 3.1a |
| 11 | FP1 2013R | 9 |  | Complex numbers | 1.1b, 3.1a |